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A NON-METRIC EXAMINATION OF THE RELATIONSHIPS BETWEEN OSTEOLOGICAL REMAINS FROM HUNGARY REPRESENTING POPULATIONS OF AVAR PERIOD

M. FINNEGAN and ANTÓNIA MARCSIK

Osteology Laboratory, Department of Sociology, Anthropology and Social Work, Kansas State University, Manhattan, Kansas, USA, and Department of Anthropology, Attila József University, Szeged

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Abstract

A sample of 317 crania representing 6 populations of the Avar period were scored for 42 non-metric cranial traits in order to generate the biological distances between these groups. The basic statistic used to measure the divergence between these groups was the Grewal-Smith statistic with some modification. Additionally, numerical taxonometric computer programs were utilized to display the relevant associations among these groups. The population samples under study were further elaborated to show the affects of side-to-side frequency differences, sex dimorphism, and age dependency of the traits utilized. This material is elaborated and presented as a preliminary report of biological divergence among the population samples tested. Continuing research is suggested to compare the non-metric analysis with traditional typological analysis.

Introduction

In recent years non-metric, i.e. qualitative variation, has become quite popular in analyzing osteological remains at the population level. Those who utilize these means suggest that the population distances generated reflect something real about the biological similarity of the populations involved and indeed can be used to show migration patterns (FINNEGAN, 1972) between populations, microrevolutionary changes (JANTZ, 1970; ORTNER—CORRUCCINI, 1976) and has been used as a useful tool in the placement of one individual into its logical population group (SJØVOLD, 1975a; FINNEGAN, 1975). Most of these workers have studied regional and/or continental populations and have utilized cranial non-metric traits to these ends. Each author justifies this approach by quoting BERRY and BERRY (1967) and OSSENBERG (1970) who suggest that, 1) the traits are highly genetic in nature; 2) that populations vary in frequencies between even closely related populations; 3) that some consistency is seen without regard to environmental variation; 4) the traits do not vary significantly with age; 5) show little sex difference; 6) show little correlation between the traits used; and 7) are easily defined and large samples can be studied in a short period of time. This by way of justification is then contrasted with the usefulness of metric traits in understanding a population or population groups. Although all of these assumptions do not hold for most populations (see below) there are many populations which can be studies utilizing these techniques or where the data can be standardized in some form to allow for any sex and age differences.

These above assumptions have been tested on many populations, most of which originate in North America or in Western Europe. However, some of the most interesting migrations and settlements are seen in Central Europe. These populations

have been analyzed by other osteological techniques, the archeology is well done, with documentation and excellent provenience, the bone material is in excellent condition, and the cultural variables have been studied in some depth.

The purpose of this paper is to utilize non-metric trait analysis in analyzing populations from the Avar period in Hungary and associated populations separated both by time and space.

Materials and Methods

A sample of 317 crania were studied for 42 non-metric cranial traits. The sample was divided into six subsets composed of 31 Kunszállás individuals, 11 male and 22 female, as reported by LIPTÁK and VARGA (1974). The second subset was that of Mélykút—Sáncdűlő showing 30 individuals evenly divided between male and female (MARCSIK, 1971). The third subset is composed of 8 males and 14 females of the Árkus—Homokbánya group as elaborated by LIPTÁK and MARCSIK (elaboration in process). The fourth subset composed of 21 males and 28 females is known as the Madaras—Téglavető elaborated by LIPTÁK and MARCSIK (1976). The fifth group and the largest subset of the current study is that of Fehértó—A—Szeged comprised of 50 males and 50 females as reported by LIPTÁK and VÁMOS (1969). The final group, Szeged—Kundomb, is composed of 41 males and 40 females and was reported by LIPTÁK and BOROSNÉ MARCSIK (1966).

Each of the above crania was scored for the following 42 cranial traits as reported by FINNEGAN (1972) (Fig. 1).

1. Highest nuchal line present

The inferior and superior nuchal lines form well marked ridges running laterally across the occipital bone inferior to the external occipital protuberance. The lighest line, when present, arises with the superior line at the external occipital protuberance, and arches anteriorly and laterally providing attachment for the epicranial eponeurosis. Many times it is more easily felt than seen. (Refer to figures for location)

2. Coronal ossicles present

Single or multiple ossicles are sometimes found in the coronal suture.

3. Ossicle at bregma present

An ossicle (the bregmatic or interfrontal bone) may be present at the junction of the sagittal and coronal sutures.

4. Sagittal ossicles present

Single or multiple ossicles are sometimes found in the sagittal suture.

5. Ossicle at lambda present

A separate bone may be observed the junction of the sagittal and lambdoid sutures. This is distinguished from an Os Inca (number seven below). An ossicle at the lambda occurs in the occipital fontanel, and is generally smaller than the Os Inca and must articulate with both parietals and the occipital bones.

6. Lambdoid ossicles present

One or more ossicles may occur in the lambdoid suture on the left side, right side or both sides. These may only articulate with one or the other parietal bones and the occipital bone.

7. Os Inca present (interparietal bone)

The portion of the occipital bone which ossifies in membrane may persist as a separate bone. The suture separating the Os Inca from the occipital bone generally runs from asterion to asterion.

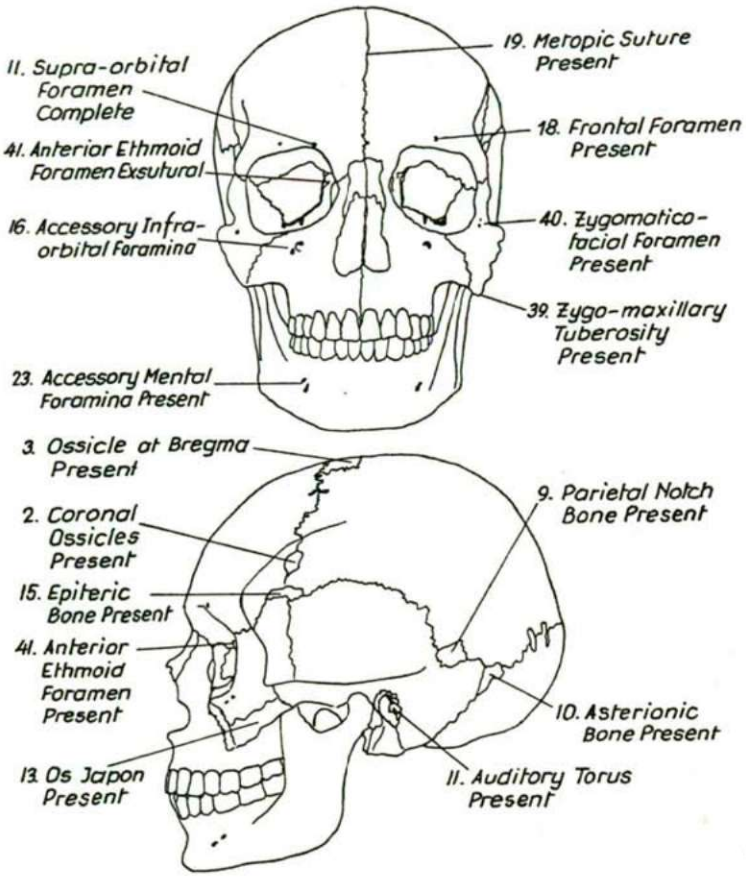


Fig. 1. Normal frontal and normal lateral views of the cranium depicting the location of non-metric traits used in this study.

8. Parietal foramen present

A foramen may occur in the parietal bone near the sagittal suture and a few centimeters above the lambda. When present, this foramen transmits a small emissary vein to the superior sagittal sinus.

9. Parietal notch bone present

A separate bone may occur in the parietal notch. The notch is defined as that part of the parietal bone that protrudes between the squamous and the mastoid portions of the temporal bone.

10. Asterionic bone present

A separate bone may occur at the junction of the lambdoid, occipito-mastoid and parieto-mastoid sutures.

11. Auditory torus present

A bony ridge may occur on the anterior or posterior walls or on the floor of the external auditory meatus.

12. Malar tubercle present (maxillary torus) Fig. 2.

The malar tubercle is a bony ridge running along the lingual aspects of the roots of the molar teeth.

13. Os Japon present (os japonicum)

A separate bone may occur as the product of the subdivision of the malar bone by a suture passing from the temporo-zygomatic suture to the zygo-maxillary suture, with some variations.

14. Pterion form (fronto-temporal articulation)

Normally the frontal bone is separated from the squamous part of the temporal bone by the greater wing of the sphenoid and the anterior inferior angle of the

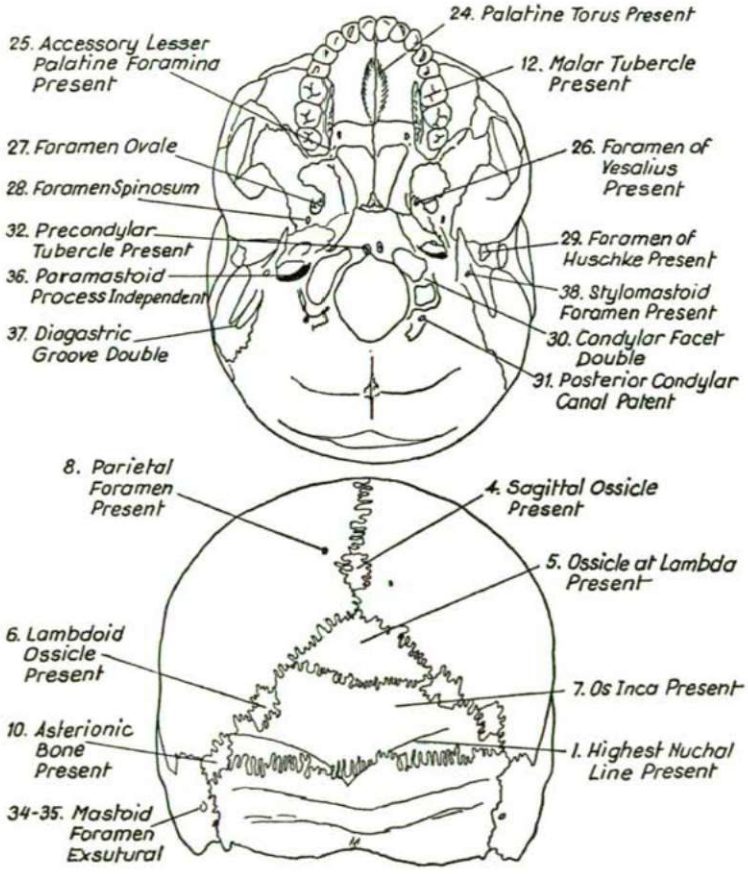


Fig. 2. Normal basilar and normal occipital views of the cranium showing the location of non-metric traits used in this study.

parietal bone. Occasionally the frontal and temporal bones are in direct contact at a point (X-form) or a line (K-form), forming a fronto-temporal articulation (not shown).

15. Epipteric bone present

An epipteric bone or pterion ossicle may be present between the parietal bone and the greater wing of the sphenoid. When large, it may also articulate with the squamous portion of the temporal bone.

16. Accessory infra-orbital foramina

One or more accessory foramina may lie immediately adjacent to the infra-orbital foramen.

17. Supra-orbital foramen complete

The supra-orbital foramen is either complete or open, in which case it is called a notch. The foramen or notch transmits the supra-orbital vessels and nerve.

18. Frontal notch or foramen present

A secondary foramen may be present lateral to the supra-orbital foramen. Frequently a cluster of pin-sized holes may occur in this area, but only a well developed foramen was scored.

19. Metopic suture present

The medio-front suture usually disappears in the first two years of life. When this suture persists into adult life, it is called metopism and is scored.

20. Mandibular foramen double

Sometimes the mandibular foramen is double or bipartite at its opening.

21. Mylohyoid groove closed (mylohyoid bridge)

A bony bridge may occur over the mylohyoid groove on the internal aspect of the ascending ramus. When this bony bridge occurs, the normally open groove is considered closed.

22. Mandibular torus present

One or more discrete bony tori occur on the internal aspect of the body of the mandible, usually below the canine and premolars.

23. Accessory mental foramina present

Accessory mental foramen may occur immediately adjacent (superiorly and posteriorly) to the primary foramen.

24. Palatine torus present

A bony ridge may run along the mid-sagittal line of the hard palate.

25. Accessory lesser palatine foramina present

Usually a single lesser palatine foramen is found immediately posterior to the greater palatine foramen and transmits the lesser palatine nerves. When more than one of these foramina are present, it is scored as accessory.

26. Foramen of Vesalius present

A small foramen may occur medial to the foramen ovale. When present, it may be seen opposite the root of the pterygoid process. It opens below, near the scaphoid fossa, and transmits a small vein from the cavernous sinus. (The position of this foramen is highly variable.)

27. Foramen ovale incomplete

Rarely, the postero-lateral wall of the foramen ovale is incomplete such that it is continuous with the foramen spinosum.

28. Foramen spinosum open

Sometimes the posterior wall of the foramen spinosum is corroded and incomplete.

29. Foramen of Huschke present (dehiscences of the tympanic plate)

The floor of the external auditory meatus contains an opening at birth, but only occasionally does it persist past the fifth year. When it does, it is scored as present.

30. Condylar facet double

Rarely, the articular surface of the occipital condyle is divided into two distinct facets.

31. Posterior condylar canal patent

The posterior condylar canal usually pierces the condylar fossa which lies immediately posterior to the occipital condyles. Sometimes this canal ends blindly in the bone. This can be scored as patent only when a seeker can be passed through the canal.

32. Precondylar tubercle present

A bony tubercle may lie immediately anterior and medial to the occipital condyle.

33. Anterior condylar canal bipartite (foramen hypoglossi) Fig. 3.

A bony spetum may occur in the anterior condylar canal dividing it into two discrete parts. In some cases this septum is only partial, but this character is not scored unless the septum is complete.

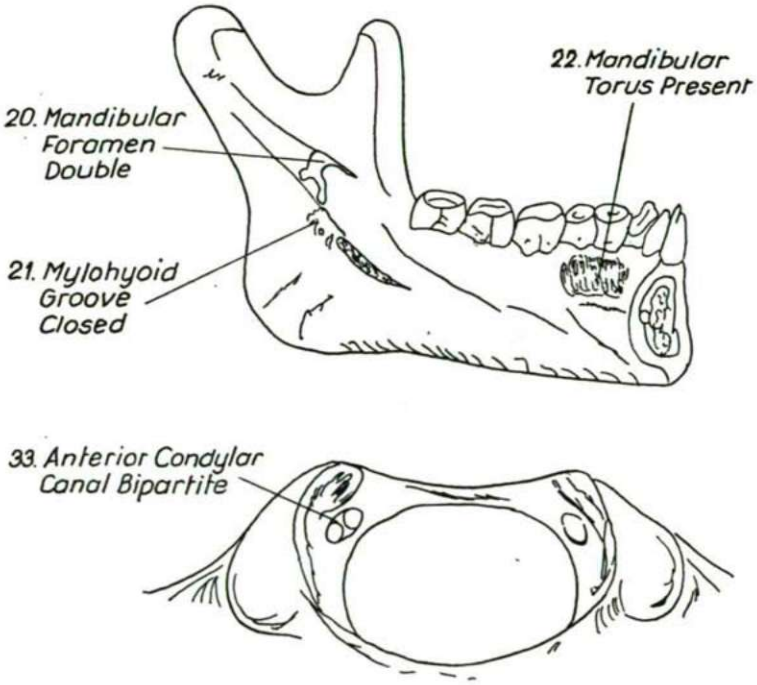


Fig. 3. The medial aspect of the left half of the mandible and the inferior anterior view of the occipital bone and occipital condyles showing non-metric traits used in this study.

34. Mastoid foramen absent

This is scored when the mastoid foramen cannot be found (See # 35).

35. Mastoid foramen exsutural

When present, the mastoid foramen lies in the occipito-mastoid suture. Sometimes it lies in the mastoid portion of the temporal bone and very rarely in the occipital bone adjacent to the occipito-mastoid suture.

36. Paramastoid process independent

This is scored when a definite downgrowth from the jugular process just medial to the mastoid process is observed.

37. Diagastric groove double

This is scored when the diagastric groove appears to be bipartite. This judgment is difficult as there is, in the same immediate area, an occipital groove for the occipital artery.

38. Stylo-mastoid foramen present

When present, this foramen lies immediately posterior to the styloid process. (Although it has been reported as absent to a small frequency in some populations, it was found absent in only one of the present study.)

39. Zygo-maxillary tuberosity present

Often a roughened downward projection at the lower end of the junction between the zygoma and the maxilla.

40. Zygomatico-facial foramen absent

There are usually one or more small foramen which pierce the zygomatic bone opposite the junction of the infra-orbital and lateral margins of the orbit. When present, it transmits a nerve and small artery.

41. Anterior ethmoid foramen exsutural

The anterior ethmoid foramen usually lies on the suture between the frontal and ethmoid bones. It is scored when it emerges above the suture.

42. Posterior ethmoid foramen absent

When present, the posterior ethmoid foramen lies on the fronto-ethmoid suture behind the anterior ethmoid foramen. (Numbers 41 and 42 are very difficult to score unless the orbits are in very good condition.) For other cranial and infracranial non-metric traits, see Finnegan and FAUST (1974).

The basic statistic used in generating the biological distances was developed by C. A. B. SMITH and used by GREWAL (1962). This statistical technique is based on the transformed frequencies of observed non-metric traits as seen by the following equation:

$$\frac{\sum_{i=1}^{R} [\theta_{1i} - \theta_{2i}]^2 - (1/\bar{N}_{1i} + 1/\bar{N}_{2i})}{R}$$

where $\theta_{1i} = \sin^{-1}(1 - 2P_{1i})$ and

r_{1i} = transformation angles of first sample ith trait
i = trait # under summation
$\bar{N}_1$ = total crania in sample 1
$\bar{N}_{1i}$ = crania of sample 1 with observable trait i

P_{1i} = % of trait i in sample $1 = \left(\frac{K1i}{\overline{N}1i}\right)$

R = # of traits for particular data set
K = count of positive observations for trait i.
(See Finnegan and COOPRIDER (1978) for alternative statistical forms.)

The first use of the Grewal—Smith statistic on human non-metric traits was produced by BERRY and BERRY (1967) and subsequent researchers developed variations of this statistic or used other statistics entirely. Some slight variations of the Grewal—Smith statistic were utilized by FINNEGAN (1972), BUIKSTRA (1972) while others, SUCHEY (1975), SJØVOLD (1973, 1975b, 1977) and GREEN and SUCHEY (1976) suggests modifications by using alternate transformations or corrections to the transformation used above. ZEGURA (1973) utilized the equation of Balakrishnan and Sanghvi's B^2 rather than the Grewal—Smith equation in order to analyze his data. Although the statistical work by GREEN and SUCHEY and SJØVOLD suggest that theoretical problems exist in the comparison of tabulated frequencies where various transformations and statistics have been employed in the final Grewal—Smith statistic, the recent work of FINNEGAN and COOPRIDER (1978) suggests that the results of empirically testing a variety of statistical transformations show no departure, one from the other, in analyzing this type of non-metric data. For these reasons the above statistic and transformation of the GREWAL—SMITH statistic were utilized.

The usefulness in the present study of non-metric traits is seen in the early justification for this method based on BERRY and BERRY (1967) and GREWAL (1962). They believe that non-metric traits may have a high genetic determination, maintain consistency in and do not suffer duress under various environmental conditions and are sensitive to frequency differences between closely related populations. Each individual who has utilized the non-metric approach justifies this approach on a quasi-genetic basis quoting Berry and BERRY (1967) and OSSENBERG (1970). Other researchers, however, have questioned many of the basic assumptions seen in the above papers asking to what degree the sides and the sexes can be pooled in making comparisons between various population samples. Also to what extent the traits are age dependent. KOREY (1970) studied side independence, sex independence, and age dependency, while BUIKSTRA (1972) studied the age correlation of non-metric traits and CORRUCCINI (1974) made a detailed investigation of side and sex dimorphism and age dependency in regard to 72 non-metric cranial traits. Many of these questions have been satisfactorily answered for a number of populations utilizing non-metric cranial studies. However the same considerations will have to be demonstrated in terms of the present paper.

Additionally world-wide continental and local population samples have been studied and offer basic data on both the traits used and total population comparisons. These are seen in the studies of Berry and BERRY (1967, 1971, 1972), CZARNETZKI (1971, 1972, 1975), KNIP (1970, 1971), LARNACH and MACINTOSH (1966, 1970, 1971, 1972), LARNACH (1974), BRUNNER (1972), PUCCIARRELLI (1972), SUBLETT (1965), BIRKBY (1973), MCWILLIAMS (1970, 1974), and ARENSBURG et al. (1977). The data presented in the present paper will help elaborate the cranial non-metric distributions for more populations from an unreported important time and area.

Results

The basic data for the six subsets currently under study are presented in Table 1. It is interesting to note that the trait Os inca and the trait auditory torus was not present in any of the six subsamples. This is an interesting departure from much of the North American native samples as seen in FINNEGAN (1972, 1974) and CYBULSKI (1975). As suggested above a number of tests on the data seen in Table 1 must be utilized prior to the acceptance of this data for the Grewal—Smith statistic.

Side-to-Side Differences

Although a number of traits show left-right side dimorphism in the female samples as determined by the presented X^2 values (See Table 2) it should be noted that as a group we would expect at least two differences at the .01 level and over 12 significant differences at the .05 level due to chance alone. This suggests that while some of the female samples show unique and in some cases consistent dimorphism from side-to-side, the dimorphism does not exceed chance expectations. In comparison, we note that in Table 3 the males display less side-to-side dimorphism than the females. Again, taking the male sample together, we find that the significant differences do not exceed chance expectations. We also see that the pattern of traits showing dimorphism are quite different between the males and females. The only trait that shows any side dimorphism in both males and females is the parietal notch bone which shows a significant side dimorphism in the female sample of the Szeged—Kundomb. In the males, a significant side dimorphism for this trait, at the .5 level, exists in the Szeged—Kundomb, Fehértó—A—Szeged and in the Kunszállás.

Inasmuch as the observed significant differences do not exceed the chance expectation for significant difference, we suggest that the sides can be statistically summed in our analysis. The reason for doing this is not only statistical but logical as well. We feel that by using only one side of the crania, we have lost some important biological data. The argument against summing the sides can be seen in the fact that where great similarity exists from side-to-side, we have increased our sample size and supposedly, artifically, decreased the variance. This is not however strictly true in that although we have few significant differences side-to-side, we have at the same time very few traits which show absolute asymmetry. It is our belief that if X^2 values are above 0.0, some difference is noted and that using one side only we would lose some biological information.

Sex Dimorphism

In comparing the sexes both left side and right side (Table 4 & 5 respectively) it was found that many traits were involved in sex dimorphism at or above the .05 and .01 level of significance. Indeed, in each group taken by itself we find that the .05 level of significance exceeds chance expectation both on the left and on the right side. At the .01 level of significance we find that only the left side exceeds chance expectations. In this case 25 of the 42 traits show a significant difference in one or more samples either on the left or the right side at the .05 or .01 level. Although the significant difference is not consistent for any particular trait over all six sub-

sets, both left and right, some comments have to be made based on this significance and the fact that it exceeds chance expectations.

Before utilizing this data with these significant differences, we obviously have to make some corrections or considerations before the sexes can be summed legitimately and used in our GREWAL—SMITH distance statistic. Various ways of doing this have been proposed. FINNEGAN (1972, 1978) has suggested that if we keep the number of males and females nearly equal in each population sample, we have adequately corrected for frequency differences displaying sex dimorphism. GAHERTY (1974) suggests that males and females could be summed for all traits which did not show sex dimorphism, and only the male or female samples be used for those traits that do display significant sex dimorphism. Gaherty's reasoning seems quite justifiable with the only disadvantage being a reduction in sample size for those traits which do show significant sex dimorphism. JANTZ (1970) attacked the sex dimorphism problem by eliminating all sexual dimorphic traits before his distance statistic was applied. Again, this can be justified, but much information is lost by the exclusion of these traits. In the present analysis 25 of the 42 traits show significant sex dimorphism in one or more subsets under study. If we were to discount the sex dimorphic traits, we would be left with a trait list of 17 traits rather than the original 42 traits. Additionally KELLOCK and PARSONS (1970) and FINNEGAN (1972) conducted principal component analysis of non-metric trait variation in human crania from a number of diverse populations and found that the largest Eigen value, accounting for the greatest percentage of total variance, was indeed a sex dimorphic trait. Each of these studies found that four traits out of the top twelve traits, in terms of the principal component analysis, were sex dimorphic. It seems clear that if we exclude the sex dimorphic traits from the current analysis, we have excluded those traits which best distinguish and define the affinitives among the subsamples in question. It therefore seems necessary that we include the traits which are sex dimorphic, but that we control to some extent the numbers of males and females within each population.

In the present study most of the populations are very evenly balanced relative to sex. Three samples, Mélykút—Sáncdűlő, Fehértó—A—Szeged and Szeged—Kundomb are evenly represented by the number of males and females. Three samples, Kunszállás, Madaras—Téglavető, and Árkus—Homokbánya show about a .60/.40 split in the sexes in each population. However in each of these populations the male frequency is the lower frequency, suggesting that a balance exists in terms of proportions between males and females in these three populations. This suggests that we can allow the summing of the sexes for use in our GREWAL—SMITH statistic. Additionally, as shown above, we feel it is legitimate to sum statistically the side as well as the sexes for our final frequency. These summed frequencies are presented in Table 1.

Age Dependency

Relatively little work has been done on age dependency in these non-metric traits. OSSENBERG (1970) suggests that a relatively small amount of age dependency would not greatly alter the significance of genetic distance studies between populations at least with regard to anthropological studies. On the other hand KOREY (1970) and BUIKSTRA (1972) suggest that age dependency of cranial traits do show some age dependency, and this dependency must be considered before distance statistics

are applied among population samples. The rationale for this by KOREY (1970) is his feeling that significant frequency correlation over the entire age range for a number of cranial traits would adversely effect an analysis of distance between populations, particularly where the age profiles in the samples under question were dissimilar. This assumption however is not totally supported in that simple age correlation will not show the magnitude of difference. This is to say that age dependent traits could be highly correlated, but frequency difference between the earlier age groups and older age groups might not be significantly different, based on a X^2 test. This technique, which is more robust than correlation, was applied by FINNEGAN (1978) to a number of populations in documenting the nature of infracranial non-metric traits. FINNEGAN found that while the correlation between age and the expression of non-metric traits were significant, the X^2 examinations, between youngest and oldest groupings within each sex, side, and race, showed the number of significant differences fell below that we would except due to chance alone. His work suggests that the age dependent nature of infracranial traits could not be fully expressed in terms of correlation coefficients and he makes the recommendation that the age regressive nature of infracranial traits does not warrant any correction in applying distance statistics unless the combined samples generate a distinct bimodal age distribution. Also, if the traits utilized between the populations can be shown to be more or less homogeneous with respect to age, then correction for age dependency is not necessary. This however may not be entirely true of cranial traits as shown by CORRUCCINI (1974).

In the present analysis, although we do not have mean ages for males and females in each subsample, we suggest that the age profile are more or less homogeneous between the sexes and among the subsamples. From the above, therefore, we determine that age dependency is not so great as to warrant a selection in the basic sample in order to match age criteria.

Distance Values

Biological distances generated by the Grewal—Smith statistic among the sample subsets is presented in Table 6 with an estimate of the variance beneath. In each possible pairings the level of significance is $P<.01$. With this number of population pairs it becomes increasingly difficult to represent all possible associations in a two dimensional graphic representation. However there are a number of numerical taxonametric methods which can be utilized to reduce this six dimensional array to a two dimensional plot. Among these are the phenogram, compiled by average linkage methods (SOKAL et al, 1963), and a stereogram of plotted eigen values (ROHLF, 1967).

The present analysis was generated based on the statistical programs offered by ROHLF et al. (1974). In this, the data from Table 6 of distances between all population pairs, were subjected to a TAXON analysis which is a sequential agglomerative hierarchical cluster analysis. In this analysis we used the unweighted pair-group method using arithmetic averages, where the lowest values are considered for similarity. This program produces a phenogram which is presented in Figure 4. The second step was to run the routine MXCOMP which is here used to compare the matrices for congruence. The elements of the first matrix are plotted against the corresponding elements in the second matrix and displayed as a bivariate scatter diagram as is

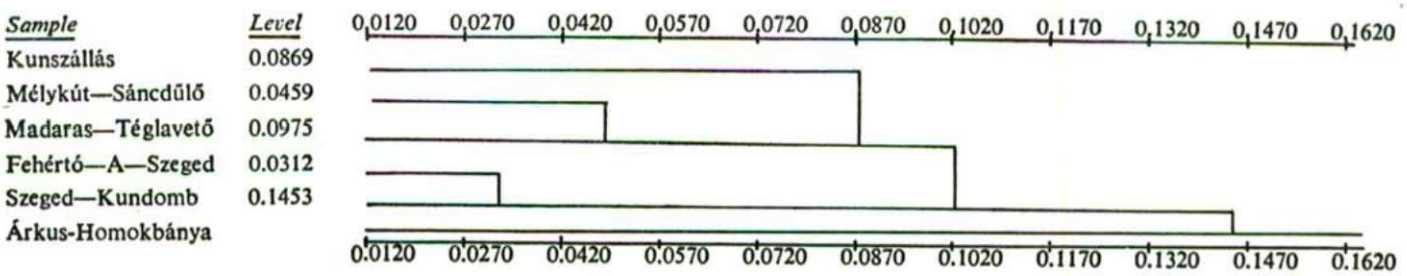


Fig. 4. A phenogram, based on the clustered distance matrix using the unweighted pair-group method with arithmetic averages. Low values were specified to indicate correspondent distance similarities.

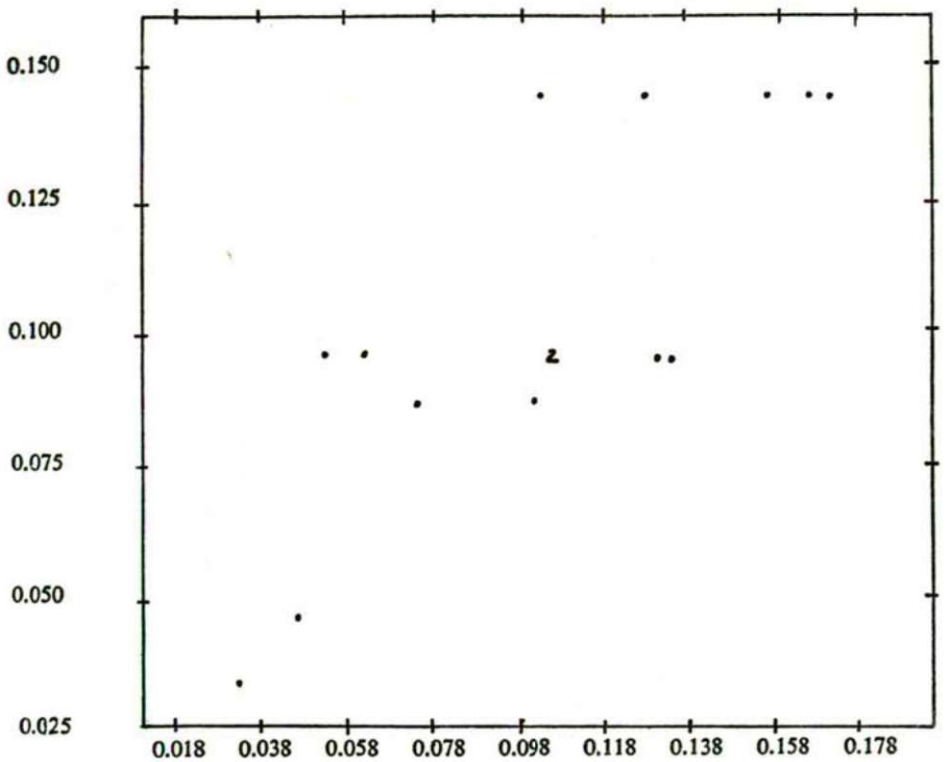
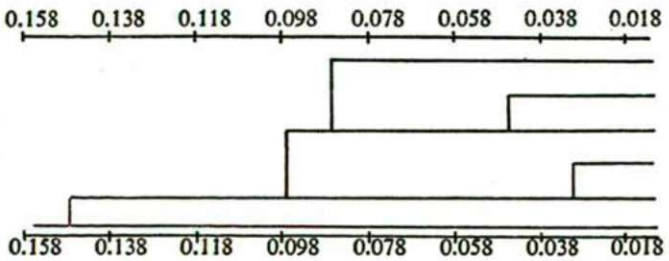


Fig. 5. A stereogram of the distance value matrix plotted against the cophenetic value matrix determined by arithmetic averages and the unweighted pair-group method. This clustering is done in order to test for the amount of distortion present in the cluster analysis. Correlation = 0.808.



Sample	*Level*
Kunszállás	0.0869
Mélykút-Sáncdűlő	0.0459
Madaras-Téglavető	0.0975
Fehértó-A-Szeged	0.0312
Szeged-Kundomb	0.1453
Árkus-Homokbánya	

Fig. 6. A phenogram derived from the matrix of cophenetic values. When comparing this with figure 4, we find little distortion in the phenogram which produces little distortion in the cluster analysis seen in figure 5.

shown in Figure 5. The correlation between these two matrices was also copmuted and was found to be 0.808, which showed a highly successfully plot. This shows the distance matrix as being clustered using the unweighted pair-group method with arithmetic averages and a cophenetic value matrix is plotted agains the original distance matrix in order to test for the amount of distortion present in the cluster analysis. The cophenetic matrix is again reduced to a phenogram, based on the average linkage method and is produced in Figure 6.

As seen in Figure 4, the greatest similarity is shown in the primary groupings of the Fehértó—A—Szeged and the Szeged—Kundomb at the 0.312 phenon level. Secondly, the hierarchical grouping is the pair made up of Mélykút—Sáncdűlő and Madaras—Téglavető at the .0459 phenon level. The Kunszállás joins the secondary group at the .0869 phenon level and these join the primary group at the .0975 phenon level. All of the above groups finally join the Árkus—Homokbánya at the .1453 phenon level. This indicates a relatively close relationship exists between Mélykút—Sáncdűlő and Madaras—Téglavető population samples and between Fehértó—A—Szeged and Szeged—Kundomb samples, with the latter pair being more closely associated.

These two pairings join at a much lower phenon level than the inclusion of the Kunszállás or the Árkus—Homokbánya samples.

The same data is essentially presented in Table 6, where the matrix is converted into a phenongram called the BDIST, which is the cophenetic matrix displayed in the phenongram and is essentially the same output as seen in Figure 4, with the exception that the interval has been generated at 100 units instead of a random unit generation.

Discussion

These data, presented in Table 6 and Figures 4, 5 and 6, should be taken at face value with little emphasis on the size of the numerical representation. Rather, the important aspect of this type of analysis is the relative numerical distance between the various population pairs. These data must at the present time speak for themselves, but we anticipate comparisons of this form of analysis with the existing traditional typological approach. It must also be noted that although the use of numerical taxonomy has produced a great deal of research in both method and technique and has been widely used in the classification of species and seriation of artifacts, tool types, etc., there are nonetheless problems connected with hierarchical ranking of various taxa. These problems are best summarized by Sokal and Sneath:

> "Those who have devised techniques for numerical taxonomy have suggested that they can be used to decide the rank of the taxa which they yield, and some suggestions have been made that agreement might be reached by biologists on the similarity levels which should define the categories of rank. To say that this is premature is to state the obvious, but the likely developments deserves some discussion. SNEATH has pointed out that there is a lower limit to the groupings which can be fitted into a nonarbitrary hierarchy. For example, different mutants of one species cannot be so arranged; it is impossible to decide whether white cats are of higher rank than long-haired cats. Such groups are not phenetic taxa; they are "rankless taxa" and cannot be satisfactorily handled

by hierarchic subspecific nomenclature. Many so-called subspecies are of this nature." (SOKAL and SNEATH, 1963).

Although we are not here dealing with subspecies in the technical sense, but rather isolate populations, spacially separated or not, and temporarily located or not, we still must consider the underlying assumptions both of the techniques and methods in numerical taxonomy of a statistical nature and the assumptions underlying the trait list used in this study in order to hierarchically rank these populations. We suggest that the populations are of equal hierarchical rank, but that we are showing the genetic similarity or closeness of fit by utilizing these numerical taxonometric techniques. We believe that by utilizing the techniques outlined in this paper we have successfully shown the genetic relationships among the populations sampled. It is now left to our future work and the work of our colleagues to document the cultural relationships relative to the biological relationships we have here defined.

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Table 2. Chi-square values for each trait in each population comparing left and right sides in females only. Significance levels: * = .05; ** = .01

Variable	Kunszállás	Mélyküt—Sáncdűlő	Árkus—Homokbánya	Madaras—Téglavető	Fehértó—A—Szeged	Szeged—Kundomb
Highest Nuchal Line	0.000	0.135	0.000	0.085	0.059	0.068
Coronal Ossicle	0.000	0.000	0.000	2.023	0.354	0.338
Ossicle at Bregma	0.000	0.000	0.000	0.000	0.000	0.000
Sagittal Ossicle	0.000	0.000	0.000	0.000	0.000	0.000
Ossicle at Lambda	0.000	0.000	0.000	0.000	0.000	0.000
Lambdoid Ossicles	0.387	0.853	4.299 *	0.497	0.000	0.016
Os Inca	0.000	0.000	0.000	0.000	0.000	0.000
Parietal Foramen	0.909	3.152	0.007	0.182	0.000	0.000
Parietal Notch Bone	1.184	0.000	0.000	2.139	2.427	6.167*
Asterionic Bone	0.000	0.000	0.000	1.713	0.729	3.385
Auditory Torus	0.000	0.000	0.000	0.000	0.000	0.000
Malar Tubercle	0.363	0.000	0.000	0.000	0.000	0.000
Os Japonicum	1.996	0.000	0.000	0.000	0.000	1.992
Pterion Form (x, k)	0.000	1.682	0.000	1.921	0.000	0.183
Epipteric Bone	0.001	0.000	0.275	1.362	0.081	0.203
Accessory Infra-Orbital Foramen	1.985	0.000	0.000	3.919*	0.785	0.421
Supra-Orbital Foramen Complete	2.973	1.250	2.708	0.798	0.299	0.965
Frontal Foramen	0.384	8.214**	0.223	1.342	0.000	2.450
Metopic Suture	0.000	0.000	0.000	0.000	0.000	0.000
Mandibular Foramen Double	0.000	0.000	2.105	4.028*	6.041*	4.221*
Mylohyoid Groove Closed	0.007	3.746	0.000	2.067	0.377	0.443
Mandibular Torus	0.085	0.000	0.000	0.000	0.118	0.000
Accessory Mental Foramen	0.426	4.211*	0.000	4.270*	3.288	2.046
Palatine Torus	0.000	0.000	0.000	0.000	0.000	0.000
Accessory Lesser Palatine Foramen	0.628	0.032	0.014	1.994	0.056	0.317
Foramen of Vesalius	0.658	1.816	0.724	0.835	0.003	0.235
Foramen Ovale Incomplete	0.488	0.068	0.056	1.597	0.680	0.000
Foramen Spinosum Open	0.071	0.173	0.753	1.962	3.072	0.325
Foramen of Huschke	0.409	0.098	0.942	0.363	0.380	3.141
Condylar Facet Double	0.000	0.000	0.000	0.000	2.030	3.957*
Posterior Condylar Canal Patent	0.904	1.824	0.004	0.109	0.185	2.410
Precondylar Tubercle	0.000	0.000	0.000	0.000	0.000	0.000
Anterior Condylar Canal Bipartite	2.372	3.509	0.167	0.418	0.208	2.414
Mastoid Foramen Absent	0.116	0.134	0.566	3.648	0.026	0.091
Mastoid Foramen Exsutural	0.011	0.227	0.501	0.618	0.259	0.000
Paramastoid Process Independent	0.010	0.000	0.000	0.000	0.000	0.007
Diagastric Groove Double	0.130	0.750	0.404	0.039	0.951	0.688
Stylo-Mastoid Foramen	1.982	0.000	0.000	0.000	0.000	0.000
Zygo-Maxillary Tuberosity	0.000	0.351	0.421	0.197	0.007	1.088
Zygomatico-Facial Foramen	0.004	0.611	4.253*	0.006	0.100	0.804
Anterior Ethmoid For. Exsutural	2.963	3.030	2.043	0.011	0.644	0.140
Posterior Ethmoid For. Absent	1.535	2.043	0.000	0.006	3.326	0.132

Table 1. Proportions of each trait in ea
this table m

Non—Metric Variable	K
Highest Nuchal Line	3
Coronal Ossicle	
Ossicle at Bregma	
Sagittal Ossicle	
Ossicle at Lambda	
Lambdoid Ossicles	1
Os Inca	
Parietal Foramen	3
Parietal Notch Bone	
Asterionic Bone	
Auditory Torus	
Malar Tubercle	
Os Japonicum	
Pterion Form (x, k)	
Epipteric Bone	
Accessory Infra-Orbital Foramen	
Supra-Orbital Foramen Complete	2
Frontal Foramen	2
Metopic Suture	
Mandibular Foramen Double	
Mylohyoid Groove Closed	
Mandibular Torus	1
Accessory Mental Foramen	
Palatine Torus	
Accessory Lesser Palatine Foramen	1
Foramen of Vesalius	1
Foramen Ovale Incomplete	
Foramen Spinosum Open	1
Foramen of Huschke	1
Condylar Facet Double	
Posterior Condylar Canal Patent	1
Precondylar Tubercle	
Anterior Condylar Canal Bipartite	
Mastoid Foramen Absent	4
Mastoid Foramen Exsutural	1
Paramastoid Process Independent	
Diagastric Groove Double	1
Stylo-Mastoid Foramen	
Zygo-Maxillary Tuberosity	3
Zygomatico-Facial Foramen	
Anterior Ethmoid For. Exsutural	1
Posterior Ethmoid For. Absent	3

Table 4. Chi-square values showing sex dimorphism within each population sample utilizing the left side only. Significance level: * = .05; ** = .01

Variable	Kunszállás	Mélykút—Sáncdülő	Árkus—Homokbánya	Madaras—Téglavető	Fehértó—A—Szeged	Szeged—Kundomb
Highest Nuchal Line	0.747	0.430	2.228	3.609	3.425	0.885
Coronal Ossicle	0.000	0.000	0.000	1.722	0.000	0.003
Ossicle at Bregma	0.000	0.000	0.000	2.337	1.993	0.000
Sagittal Ossicle	2.565	0.000	2.660	1.722	0.299	0.396
Ossicle at Lambda	1.504	1.985	4.468*	0.755	2.293	1.185
Labdoid Ossicles	0.216	0.530	17.351**	0.110	0.379	1.573
Os Inca	0.000	0.000	0.000	0.000	0.100	0.000
Parietal Foramen	0.257	0.164	0.462	0.603	0.000	0.813
Parietal Notch Bone	1.504	0.000	0.000	0.000	0.100	12.493**
Asterionic Bone	0.000	2.268	0.000	1.751	0.354	0.686
Auditory Torus	0.000	0.000	0.000	0.000	0.000	0.000
Malar Tubercle	0.002	0.000	0.000	0.000	0.000	0.000
Os Japonicum	1.370	0.000	0.000	0.000	1.953	2.097
Pterion Form (x, k)	5.528*	2.132	0.000	1.638	0.354	2.285
Epipteric Bone	1.468	0.000	2.393	3.688	0.950	2.717
Accessory Infra-Orbital Foramen	0.000	1.566	0.000	3.919*	0.001	0.000
Supra-Orbital Foramen Complete	0.067	0.025	0.004	7.236**	0.002	1.490
Frontal Foramen	0.294	1.961	0.004	2.555	0.655	0.054
Metopic Suture	0.007	0.000	2.507	1.671	0.545	0.333
Mandibular Foramen Double	0.000	1.961	0.000	0.081	8.055**	0.003
Mylohyoid Groove Closed	1.678	0.000	0.000	0.000	0.000	0.438
Mandibular Torus	0.674	0.000	0.000	5.146*	2.184	0.338
Accessory Mental Foramen	0.030	4.492*	2.552	0.081	1.103	4.154*
Palatine Torus	0.159	1.481	3.568	0.063	2.904	0.693
Accessory Lesser Palatine Foramen	0.011	0.783	0.041	0.562	0.354	0.135
Foramen of Vesalius	2.353	2.240	0.690	0.458	0.364	0.032
Foramen Ovale Incomplete	0.273	2.587	3.840*	1.909	0.332	0.311
Foramen Spinosum Open	0.205	1.759	0.036	1.794	0.660	1.066
Foramen of Huschke	0.147	1.336	4.922*	2.416	0.188	10.576**
Condylar Facet Double	0.000	1.792	0.000	0.000	6.179*	4.068*
Posterior Condylar Canal Patent	0.057	0.180	0.436	0.127	3.121	2.112
Precondylar Tubercle	1.645	1.910	0.000	0.715	0.552	2.244
Anterior Condylar Canal Bipartite	0.151	0.006	0.000	5.489*	1.996	1.193
Mastoid Foramen Absent	0.019	0.348	1.043	0.792	3.439	0.518
Mastoid Foramen Exsutural	1.403	0.163	3.631	2.071	4.560*	3.609
Paramastoid Process Independent	0.086	5.600*	0.000	8.065**	1.591	1.360
Diagastric Groove Double	0.560	0.712	0.019	1.260	2.248	1.794
Stylo-Mastoid Foramen	0.000	0.000	0.000	0.000	0.000	0.000
Zygo-Maxillary Tuberosity	0.313	0.237	6.601*	0.603	6.423*	1.599
Zygomatico-Facial Foramen	0.000	0.012	0.362	0.330	0.544	0.625
Anterior Ethmoid For. Exsutural	0.140	0.000	0.000	0.211	0.184	1.953
Posterior Ethmoid For. Absent	3.012	0.022	0.000	0.163	4.508*	2.071

Table 5. Chi-square values showing sex dimorphism within each population sample utilizing the right side only. Significance level: * = .05; ** = .01

Variable	Kunszállás	Mélykút—Sáncdűlő	Árkus—Homokbánya	Madaras—Téglavető	Fehértó—A—Szeged	Szeged—Kundomb
Highest Nuchal Line	0,010	1.025	2.228	4.712*	3.191	1.815
Coronal Ossicle	0.000	0.000	0.000	0.000	4.054*	0.002
Ossicle at Bregma	0.000	0.000	0.000	2.337	1.993	0.000
Sagittal Ossicle	2.565	0.000	2.660	1.722	0.299	0.396
Ossicle at Lambda	1.504	1.985	4.468*	0.755	2.293	1.185
Lambdoid Ossicles	0.395	0.433	19.831**	0.013	0.379	0.084
Os Inca	0.000	0.000	0.000	0.000	0.000	0.000
Parietal Foramen	0.039	4.268*	0.134	0.402	1.007	0.952
Parietal Notch Bone	0.028	2.132	0.000	0.006	0.729	1.262
Asterionic Bone	0.000	0.000	0.000	0.231	0.122	2.146
Auditory Torus	0.000	0.000	0.000	0.000	0.000	0.000
Malar Tubercle	0.282	0.000	0.000	0.000	0.000	0.000
Os Japonicum	0.000	0.000	0.000	0.000	1.993	0.000
Pterion Form (*x*, *k*)	2.716	0.000	0.000	0.000	1.993	1.262
Epiteric Bone	0.209	1.566	0.984	0.146	0.081	2.250
Accessory Infra-Orbital Foramen	1.068	0.000	0.000	2.202	0.000	0.134
Supra-Orbital Foramen Complete	2.067	0.018	8.512**	0.898	0.299	0.054
Frontal Foramen	1.516	0.112	1.458	0.206	0.299	1.804
Metopic Suture	0.007	0.000	2.507	1.671	0.545	0.333
Mandibular Foramen Double	0.000	0.000	1.263	2.348	0.137	3.964*
Mylohyoid Groove Closed	0.125	3.900*	0.000	1.697	0.001	0.001
Mandibular Torus	0.332	0.000	0.000	5.146*	3.321	3.244
Accessory Mental Foramen	2.809	1.986	2.658	2.407	0.338	2.118
Palatine Torus	0.159	1.481	3.568	0.063	2.904	0.693
Accessory Lesser Palatine Foramen	0.099	1.850	1.946	0.361	0.033	0.841
Foramen of Vesalius	0.011	0.794	0.439	1.214	0.826	0.978
Foramen Ovale Incomplete	1.346	4.253*	1.755	1.186	0.729	0.299
Foramen Spinosum Open	0.037	2.502	0.253	3.876*	0.386	0.325
Foramen of Huschke	2.119	0.512	2.279	0.301	4.488*	0.003
Condylar Facet Double	0.000	1.640	0.000	0.000	0.000	0.003
Posterior Condylar Canal Patent	0.189	2.341	0.179	0.066	0.423	0.544
Precondylar Tubercle	1.645	1.910	0.000	0.715	0.552	2.244
Anterior Condylar Canal Bipartite	1.178	3.677	0.027	0.117	0.545	2.105
Mastoid Foramen Absent	4.302*	2.416	3.872*	0.657	0.062	0.091
Mastoid Foramen Exsutural	1.770	0.859	0.464	0.505	3.257	0.104
Paramastoid Process Independent	0.037	5.040*	0.000	4.910*	0.886	0.411
Diagastric Groove Double	0.008	2.748	0.006	0.275	2.202	0.832
Stylo-Mastoid Foramen	1.444	0.000	0.000	0.000	0.000	0.000
Zygo-Maxillary Tuberosity	0.051	0.038	0.799	0.000	5.768*	1.678
Zygomatico-Facial Foramen	0.003	0.000	0.000	0.001	6.386*	0.015
Anterior Ethmoid For. Exsutural	0.297	4.743*	1.021	0.120	0.388	0.097
Posterior Ethmoid For. Absent	0.795	2.724	0.000	1.022	0.058	2.597

Table 6. Measures of divergence between population samples used in this study. The underwritten italicized figures are estimates of the variance. In each case these show th, measure of diver gen to be significant at or above the .01 level. Measures of divr rgence and estimates of the varian ce are based on the Grewal-Smith statistic

Population Sample	Kunszállás	Mélykút—Sáncdűlő	Árkus—Homokbánya	Madaras—Téglavető	Fehértó—A—Szeged
Mélykút—Sáncdűlő	.100				
	.002				
Árkus—Homokbánya	.156	.131			
	.004	*.003*			
Madaras—Téglavető	.074	.046	.104		
	.001	*.000*	*.002*		
Fehértó—A—Szeged	.131	.135	.166	.060	
	.002	*.002*	*.004*	*.001*	
Szeged—Kundomb	.104	.104	.169	.050	.031
	.001	*.002*	*.004*	*.000*	*.000*

References

ARENSBURG, B.—GOLDSTEIN, M. S.—NATHAN, H. (1977): Metopism in Bedouin crania from the Negev of Israel. — Z. Morph. Anthrop. *68*, 293—297.

BERRY, A. C.—BERRY, R. J. (1967): Epigenetic variation in the human cranium. — J. Anat. *101*, 361—379.

BERRY, A. C.—BERRY, R. J. (1971): Epigenetic polymorphism in the primate skeleton. In Comparative Genetics in Monkeys, Apes and Man. (In: BROTHWELL, D.—CHIARELLI, A. B. eds.) Academic Press London.

BERRY, A. C.—BERRY, R. J. (1972): Origins and relationships of the ancient Egyptians. Based on a study of non-metrical variations in the skull. — J. Hum. Evol. *1*, 199—208.

BIRKBY, W. H. (1973): Discontinuous morphological traits of the skull as population markers in the prehistoric southwest. — Ph. D. Dissertation, University of Arizona.

BRUNNER, JOHN A. (1972): Die Fruhmittelalterliche Bevölkerung von Bonaduz. — Eine anthropologische Untersuchung, Chur.

BUIKSTRA, J. (1972): Hopewell in the lower Illinois River Valley: a regional approach to the study of biological variability and mortuary activity. — Ph. D. Dissertation, University of Chicago.

CORRUCCINI, R. S. (1974): An examination of the meaning of cranial discrete traits for human skeletal biological studies. — Am. J. Phys. Anthr. *40*, 425—446.

CYBULSKI, J. S. (1975): Skeletal variability in British Columbia Coastal populations: a descriptive and comparative assessment of Cranial morphology. — National Museum of Man, Mercury Series, Archaeological survey of Canada, paper 30.

CZARNETZKI, A. (1971): Epigenetische Skelettmerkmale im Populationsvergleich. I. Rechts-links-—Unterschiede bilateral angelegter Merkmale. — Z. Morph. Anthrop. *63*, 238—254.

CZARNETZKI, A. (1972): Epigenetische Skelettmerkmale im Populationsvergleich. II. Frequenzunterschiede zwischen den Geschlechtern. — Z. Morph. Anthrop. *63*, 341—350.

CZARNETZKI, A. (1975): Epigenetic Distance and Allopatry. — J. Hum. Evol. *4*, 483—489.

FINNEGAN, M. (1972): Population definition on the Northwest Coast by analysis of discrete character variation. — Ph. D. Dissertation, University of Colorado, Boulder.

FINNEGAN, M. (1974): A migration model for Northwest North Amerika. (in: International Conference on the Prehistory and Paleoecology of Western North American Artic and Subartic. Raymond, S. — Schledermann, P. eds.) — University of Calgary Press, 57—73.

FINNEGAN, M. (1975): The use of non-metric traits in assigning individuals to a parent or larger group. Paper presented at the Plains Conference 7 November 1975, Lincoln, Nebraska.

FINNEGAN, M. (1978): Non-metric variation of the infracranial skeleton. — J. Anat. *125*, 23—37.
FINNEGAN, M.—COOPRIDER, K. (1978): Emperical comparison of distance equations using discrete traits. — Am. J. Phys. Anthr. In press.
FINNEGAN, M.—FAUST, M. A. (1974): Bibliography of Human and Nonhuman Nonmetric Variation. Research Reports, 14. University of Massachusetts, Amherst.
GAHERTY, GEOFFREY (1974): Infracranial Discrete Traits in Seven African Populations. — Paper presented at the 43rd annual meeting of The AAPA, 11, 12 April 1974, Amherst Mass.
GEER, R. F.—SUCHEY, J. M. (1976): The use of inverse sine transformations in the analysis of non-metric cranial data. — Am. J. Phys. Anthrop. *45*, 61—68.
GREWAL, M. S. (1962): The rate of genetic divergence of sublines in the C57BL strain of mice. — Gen. Res. *3*, 226—237.
JANTZ, R. L. (1970): Change and variation in skeletal populations of Arikara Indians. — Ph. D. Dissertation, University of Kansas, Lawrence, Kansas 1970.
KELLOCK, W. L.—PARSONS, P. A. (1970): A comparison of the incidence of minor non-metrical cranial variants in Australian Aborigines with those of Melanesia and Polynesia. — AJPA. *33*, 235—240.
KNIP, A. S. (1970): Metrical and non-metrical measurements on the skeletal remains of Christian populations from two sites in Sudanese Nubia. Part I and II. Koninklijke Nederlandse Akademie van Wetenschappen, Proceedings, Serie C. — Biol. and Med. Sciences, *73*, 433—468.
KNIP, A. S. (1971): The frequency of non-metrical variations in Tellem and Nokara skulls from the Mali Republic. Part I. Part II. Proceedings of the Koninklijke Nederlandse Akademie van Wetenschappen, Serie C. — Biol. and Med. Science, *74*. 422—443.
KOREY, K. (1970): Characteristic of the distribution of non-metric variants. Master's Thesis, University of Chicago.
LARNACH, S. L. (1974): An ewamination of the use of discontinuous cranial traits. — Arch. and Phys. Anthrop. in Oceania. *9*, 217—225.
LARNACH, S. L.—MACINTOSH, N. W. G. (1966): The craniology of the Aborigines of Coastal New South Wales. — The Oceania Monographs, 13.
LARNACH, S. L.—MACINTOSH, N. W. G. (1970): The craniology of the Aborigines of Queensland. — The Oceania Monographs. 15.
LARNACH, S. L.—MACINTOSH, N. W. G. (1971): The mandible in Eastern Australian Aborigines. — The Oceania Monographs. 17.
LARNACH, S. L.—MACINTOSH, N. W. G. (1972): The Keppel Islanders. A supplement to the craniology of Queensland. — Arch. and Phys. Anthrop. in Oceania, *7*, 8—14.
LIPTÁK P.—BOROSNÉ MARCSIK A. (1966): Szeged—Kundomb avar kori népességének embertani vizsgálata (Die anthropologische Untersuchung des Gräberfeldes Szeged—Kundomb aus der Awarenperiode). — Anthr. Közl. *9*, 13—56.
LIPTÁK P.—MARCSIK A. (1976): A Madaras—Téglavető avar temető csontvázmaradványainak embertani jellemzése. Anthropologische Charakteristik der Skelettreste aus dem Awarischen Gräberfeld bei Madaras—Téglavető. — Cumania, IV. Archaeologia. 115—140.
LIPTÁK P.—MARCSIK A. (elaboration in progress): Árkus—Homokbánya.
LIPTÁK P.—VÁMOS K. (1969); A Fehértó—A megnevezésű avar kori temető csontvázanyagának embertani vizsgálata (Anthropologische Untersuchung des Skelettmaterials des Awarenzeitlichen Gräberfeldes von „Fehértó—A.). — Anthrop. Közl. *13*, 3—30.
LIPTÁK, P.—VARGA, I. (1974): Charakterisierung des anthropologischen Materials des awarischen Gräberfeldes von Kunszállás. — MFMÉ. 1971/2. 71—83.
MARCSIK A. (1971): A mélykúti avarkori temető embertani leleteinek vizsgálata (Anthropological investigation of a cemetery at Mélykút from the Avar period). — Anthrop. Közl. *15*, 87—95.
MCWILLIAMS, D. (1970): Physical Anthropology of Wann and Sam, Two Fourche Maline Focus Archaic Sites in Eastern Oklahoma. — Bull. — Oklahoma Anthr. Society, 19.
MCWILLIAMS, K. R. (1974): Gran Quivira Pueblo and Biological Distance in the U.S. Southwest. — Ph. Dissertation, Arizona State University.
ORTNER, D. J.—CORRUCCINI, R. S. (1976): The Skeletal Biology of the Virginia Indians. — Am. J. Phys. Anthr. *45*, 717—722.
OSSENBERG, NANCY S. (1970): The influence of artificial cranial deformation on discontinuous morphological traits. — Am. J. Phys. Anthr. *33*, 357—372.
PUCCIARELLI, HECTOR M. (1972): Relaciones Entre Huesos Wormianos Y Otros Rasgos Neurocraneanos Sobre un Grupo Racial Homogenoe. — Anales De La Sociedad Cientifica Argentina.

ROHLF, F. JAMES (1967): Correlated Characters in Numerical Taxonomy Systematic Zoology. *16* 109—126.

ROHLF, F. J.—KISHPAUGH, J.—KIRK, D. (1974): Numerical Taxonomy System of Multivariate Statistical Programs. — Department of Ecology and Evolution, The State University of New York at Stony Brook, Stony Brook, New York 11790.

SJØVOLD, T. (1973): The occurrence of minor non-metrical variants in the skeleton and their quantitative treatment for population comparisons. — Homo, *24*. 204—233.

SJØVOLD, T. (1975a): Allocation of single or some few individuals to one of two or more groups by means of non-metrical variants in the skeleton. — Ossa, *2*. 41—46.

SJØVOLD, T. (1975b): On some measures of distance or divergence between populations. Paper presented 14th Yugoslav Congress of Anthropologist, Zagreb, *17*. 1975.

SJØVOLD, T. (1977): Non-metrical Divergence Between Skeletal Populations. — Ossa, *4*, Supplement *1*.

SOKAL, R. R.—SNEATH, P. H. (1963): Principles of Numerical Taxonomy. Freeman and Co.: San Francisco.

SUBLETT, AUDREY J. (1965): The Cornplanter Cemetery: Skeletal Analyses. — Pennsylvania Archaeologist *35*, 74—91.

SUCHEY, J. M. (1975): Biological Distance of Prehistoric Central California Populations Derived from Non-metric Traits of the Cranium. — Ph. D. Dissertation, University of California, Riverside.

ZEGURA, STEVE (1973): A comparison of distance matrices derived from craniometric measurements and cranial observations. — Paper presented at the 1973 annual meeting of the AAPA, Dallas, Texas.

Address of the authors:
M. FINNEGAN Ph. D
Osteology Laboratory, Department of Sociology, Anthropology and Social Work, Kansas State University, Manhattan, Kansas, USA
Dr. ANTÓNIA MARCSIK
Department of Anthropology, A. J. University, H—6701 Szeged, P. O. Box 428, Hungary